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甘肃临夏盆地的渐新世巨犀化石[1)]

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摘要: 描述了2种巨犀化石:霍尔果斯准噶尔巨犀(*Dzungariotherium orgosense*)和牙沟副巨犀(新种)(*Paraceratherium yagouense* sp. nov.)。新种的主要特征是:个体小;上颊齿齿冠高,有薄层白垩质覆盖;DP2～M1反前刺大,原尖后收缩沟明显,次尖有深的前收缩沟,中谷和后凹中常有附属小柱等。巨犀的演化历史可能比过去想象的更复杂。*Indricotherium*、*Dzungariotherium*和*Paraceratherium*为代表不同进化水平和支系的3个属,不应合并为*Paraceratherium*一属。牙沟含巨犀化石层位的地质时代为晚渐新世。

关键词: 甘肃省临夏盆地,渐新世,巨犀
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1 前言

临夏盆地巨犀化石的首次报道见于邱占祥等"甘肃东乡几种早中新世哺乳动物化石"一文(1990)。化石是从东乡族自治县药材收购站收集的,据称来自椒子沟的底部,祁牙村附近。巨犀化石共有十几颗下颊齿,其中只有属于同一个体的p3和p4保存较好,被鉴定为*Dzungariotherium orgosense*。由于在一起收集到的化石中有一段象的门齿,这个地点的地质时代当时被推测为早中新世。

2002年7月底邱占祥、王伴月在检查和政县政府征集的马占龙家的"龙骨"时,发现其中有保存相当完好的巨犀化石,不但有较多的上、下颊齿,而且还有头骨。同时发现的还有查干鼠、鬣齿兽、巨獠犀、爪兽等。经过调查了解,证实化石来自东乡族自治县东塬乡的牙沟。但在牙沟没有发现任何象类化石的踪迹。牙沟距椒子沟很近。经沿层追索,证实牙沟和椒子沟的化石产于同层,即椒子沟组下段的褐黄色砂砾岩。在椒子沟收集到的一段象牙门齿很可能是从上覆地层的化石中混入的。椒子沟组下段含化石地层的时代应为晚渐新世,而不是早中新世。巨犀是这批化石中数量较多而保存较好的,对于了解临夏盆地的巨犀化石的性质和含化石地层的地质时代具有重要意义。

本文暂采用Gromova (1959)对巨犀类颊齿冠面要素所建议使用的术语。其中下颊齿的下后脊系指由前、外和后三部分组成的U形脊。

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2 化石记述

霍尔果斯准噶尔巨犀 Dzungariotherium orgosense **Qiu (= Chiu) , 1973**

(图 1～3;表 1)

材料 IVPP V 13571 ,右 P2 ;V 13807 , 右 P3 ;V 13862 , 右 P4 ,外脊外壁及后脊破损 ; V 13808 - 1～3 ,左 P4 和左、右 M2 ,P4 外脊缺失 ;V 13809 ,左 M3 ;V 13810 ,左 M3 ,外后脊部分破碎 ;V 13811 ,右 M3 ;V 13812 ,右 M3 ;V 13813 ,右 M3 ,原脊破坏 ;V 13814 ,左 i1 ;V 13815 , 左 p2 ;V 13816 ,左 p2 ;V 13817 - 1～4 ,左 p3～m1 和 m3 ;V 13818 ,右 m2 ;V 13819 ,第三掌或蹠骨的远端。

描述 P2 (V 13571 ,图 1 A) 近三角形 ,长稍大于后宽。前附尖细长。前附尖褶深窄 , 其后的外壁强烈隆凸。原脊细长 ,S 形 ,约以 45°角斜向内后方 ,原尖不明显膨大。后脊稍长于原脊 ,轻微斜向内后方 ,和外壁的连接处较原脊窄而低 ,在接近次尖处有一小的前刺 , 但稍经磨耗即消失。次尖特别膨大 ,与原尖仅在最基部相连 ,但分隔沟很清楚。外脊内壁有一圆隆的小刺。中谷宽大于长 ,内端仅在齿冠基部封闭。后凹较宽大。整个牙齿以齿带环围 ;前内齿带和后齿带的内半段高耸 ,呈带状 ;后齿带的外半段薄而低 ,自内向外急剧向齿冠方向升高 ;后齿带的中部为一 V 形切迹 ;外齿带明显 ,但微弱(后半部破失) 。

P3 (V 13807 ,图 1 B) 近梯形 ,宽大于长 ;前内角圆而内收 ,前、后附尖稍稍超出牙齿的前、后缘。外壁微隆 ,有浅的前附尖褶。原脊呈弧形弯向内后方 ,与次尖完全愈合。次尖稍膨大 ,在舌侧壁以一浅沟和原脊分开。后小尖脊形 ,与牙齿长轴垂直 ,稍经磨耗即与外脊和次尖的前端连接 ,形成后脊 ,并将中谷封闭。后凹小 ,后端不封闭。小刺发育 ,但较圆钝。前、内和外齿带与 P2 者同 ,后齿带中部没有 V 形切迹。

P4 (V 13808 - 1 ,图 1 C) 外脊的内壁破损(图中画斜线的部分) 。它和 P3 在形态上非常接近 ,但前附尖褶更深而明显 ,后小尖为向后凸出的弧形 ,次尖和原脊在舌侧壁上的分割沟也更明显 ,齿带与 P3 者同 ,但更粗壮。

标本中没有 M1 ,而有 2 个 M2 ,它们可能和上述 P4 为同一个体。左 M2 (V 13808 - 2 , 图 1 D) 轮廓近一梯形 ,外长内短 ,前宽后窄。前附尖伸向前外方 ,在齿冠中部长约 20 mm。前附尖褶深 ,外壁在后尖之前有一弱沟。原脊稍弯曲 ,原尖有窄细的前收缩沟和宽缓的后收缩沟 ,舌面平 ,有明显的垂直沟 ;反前刺大而圆隆 ,在齿冠基部将中谷封闭。后脊较原脊短而直 ,次尖有窄细的前收缩沟 ,此沟在接近齿冠基部时弯向舌侧。前、后齿带高脊状 ;内齿带在原尖内面细弱 ,在原尖垂直沟处明显 ,在中谷处亦发育 ,但在次尖舌面无 ;外齿带低 ,在后尖处最明显。

标本中有 5 个 M3 ,轮廓都为三角形。前附尖、前尖和原脊与 M2 者非常接近。外脊与后脊愈合为外后脊 ,其外后壁圆隆 ,而不呈角形。在一件标本上(V 13812) ,外后脊最隆处之内有一垂向沟 ;次尖有前收缩沟。在两件标本上(V 13809 和 V13811 ,图 1 E) ,在外后脊内壁的内 1/3 处可见有一小的前刺。在其他 3 件标本上外后脊的内壁光滑。在仅保留后半部的 M3 (V 13813) 上 ,中谷内端谷底有一隆起。在外后脊破损的 M3 (V 13810 图 1 F) 上 ,隆起变为尖锥状突起 ;在反前刺之外还有锥状突起。M3 的齿带和 M2 者同 ,但在原尖

内面和次尖后方齿带的强弱有变化。在磨耗较轻的 M3 (V 13811 , 图 1 E) 上尚未磨耗的前尖处的冠高(带齿带)为 97.5 mm ,而轻度磨耗的次尖处的冠高(带齿带)为 66 mm。

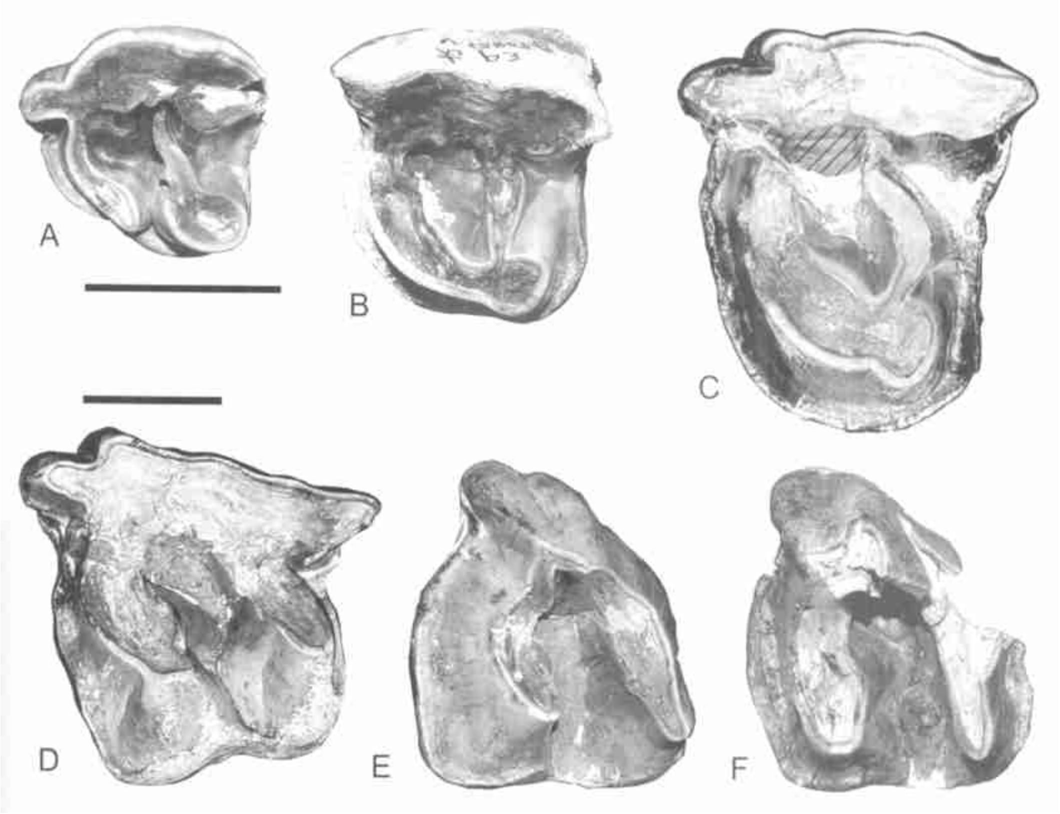

图 1　霍尔果斯准噶尔巨犀上颊齿冠面观

Fig. 1　Occlusal view of upper cheek teeth of *Dzungariotherium orgosense*

A. 右 right P2 (V 13571 , 翻转 reverse) ; B. 右 right P3 (V 13807 , 翻转 reverse) ;C. 左 left P4 (V 13808 - 1) ; D. 左 left M2 (V 13808 - 2) ; E. 右 right M3 (V 13811 , 翻转 reverse) ;F. 左 left M3 (V 13810) ; 标尺 scale = 5 cm (A～C 同一标尺 same scale ; D～F 同一标尺 same scale)

下门齿(i1 ,图 2)的齿冠 ,在大小和形态上和 Gromova (1959) 记述的 *Paraceratherium prohorovi* 的非常接近。齿冠断面椭圆形 ,近中面较平 ,远中面隆凸。自侧面看 ,上、下缘皆微凹。齿冠向前上方翘起 ,齿根直。齿冠和齿根的界线自后上斜向前下方。下棱脊形。齿冠近中面的前下角有一台阶状隆起 ,与其内后方宽大的齿带愈合。和 Gromova 所记述的门齿的区别是 ,牙沟的门齿的前端在垂向上较高 ,侧向较扁 ,其磨耗面为长椭圆形;此外 ,牙沟门齿的上棱不发育;齿根侧面没有纵沟。齿冠前后长 52.5 mm ,最大高 36.6 mm ,最大宽 32 mm。

p2 (V 13815 ,图 3 A) 很小 ,单根。冠面轮廓为圆三角形。主尖大 ,向前伸出一脊 ,脊的末端稍膨大 ,内侧以一沟和主尖分开;自主尖向内后方伸出一短脊 ,此脊向齿冠基部逐渐加长至牙齿后缘;自主尖向后方伸出一较长的脊 ,它和伸向后内方的脊形成后凹。牙齿外壁圆隆 ,有两条垂向棱。齿带包围整个牙齿。

p3 (V 13817-1 ,图 3 A) 轮廓近三角形。下后脊磨耗深时形成内端向后斜的 U 形;下前

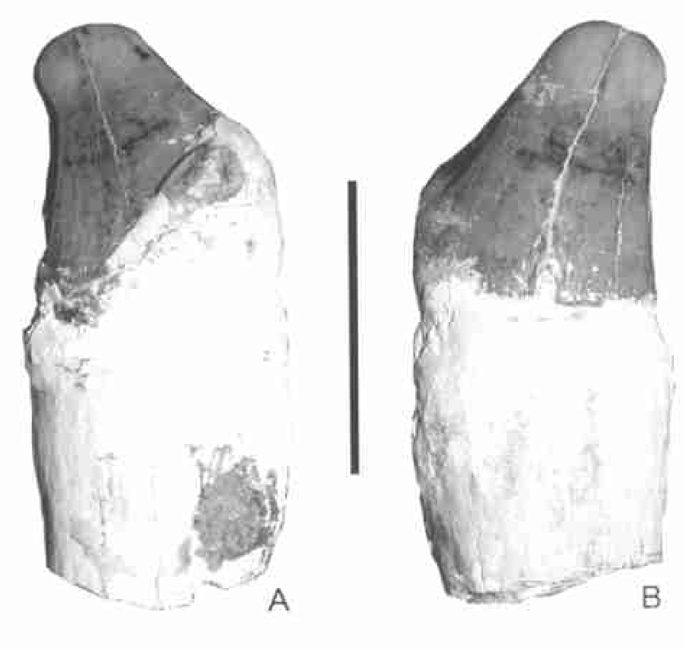

图 2 霍尔果斯准噶尔巨犀下门齿 (V 13814)

Fig. 2 Lower incisor (V 13814) of *Dzungariotherium orgosense*

A. 近中观 mesial view; B. 远中观 lateral view; 标尺 scale = 5 cm

尖脊形,其内端在牙齿基部伸达牙齿内缘,但较下后脊的后部(由下后尖与下原尖连成的脊)明显地细弱而短,两者都斜向内后方;下后尖的内后角脊形,向基部增大;下原尖的外后角隆起,至基部形成小突起,其前、后方均有窄沟(见图 3 A1)。下次脊横脊部分大致与牙齿长轴垂直,内端微向前弯;下内尖与下次脊完全愈合。外中谷浅,窄沟形。齿带包围整个牙齿,内齿带高耸。

p4 (V 13817-2) 形态介于 p3 和 m1 之间,前窄后宽。下后脊 U 字形,两横脊长于纵脊;下前尖脊向内降低,其内端高度约为冠高的一半;下后脊的后横脊(由下原尖和下后尖相连组成)粗壮,接近垂直于牙齿长轴;下后尖膨大,内面平,至齿冠基部变宽;下原尖外后角较圆隆,没有突起。下次脊和 p3 者一样。外中谷深,但较宽缓。齿带与 p3 者相同,但更粗壮。

和上述 p3～p4 为同一个体的 m1 (V 13817-3,图 3 A) 磨耗已很深。m2 (V 13818,图 3 C) 磨耗较轻,但下前尖部分破失。它们和下前臼齿的区别是下前尖为高而粗的脊形,下内尖高于下次脊的其他部分,外中谷宽浅和内齿带仅在前、后谷口处发育。和上述 p3～m1 为同一个体的 m3 (V 13817-4,图 3 B) 尚未磨耗,保存完好。下后脊 U 字形,其纵脊向前急剧下降至下前尖水平;下前尖形成很薄的横脊,顶端锐,略向后弯,向舌侧下降缓;下后脊的后横脊稍斜向后内方;下后尖在顶端弯向前方;前内谷为狭长沟形;下原尖外后角圆隆。下次脊的外后角圆,下内尖微向前弯。外中谷深。下后脊外壁最高处高(带齿带)为 71 mm;下次脊最高处(带齿带)约为 62 mm(齿带处破坏)。

肢骨中仅有一第三掌或蹠骨的远端。最大宽 131 mm,关节面处宽 117 mm,厚 102 mm。

比较与讨论 牙沟材料中的 p3 和 p4 和邱占祥等(1990)记述的椒子沟的材料在形态上几乎完全一样,具有 *Indricotherium* 和 *Paraceratherium* 两者的特征。其下原尖外后角呈角状突起,与 *Indricotherium* 一样,而不同于 *Paraceratherium* 者。后者的下原尖外后角圆隆。但 p3 接近三角形,p4 前窄后宽,下内尖与下次脊完全愈合,则和 *Paraceratherium* 相同,而不同于 *Indricotherium* 者。后者的 p3 和 p4 的轮廓为长方形,下内尖不与下次脊完全愈合,而呈分离的锥形。在大小上,椒子沟的牙齿比牙沟者稍小(表 1),但都比已知的 *Indricotherium* 和 *Paraceratherium* 的大。因此,把牙沟和椒子沟的材料归为同种是合理和可靠的。

牙沟的材料包括了除 M1 之外的全部上、下颊齿,这使我们对临夏盆地这类巨犀的牙

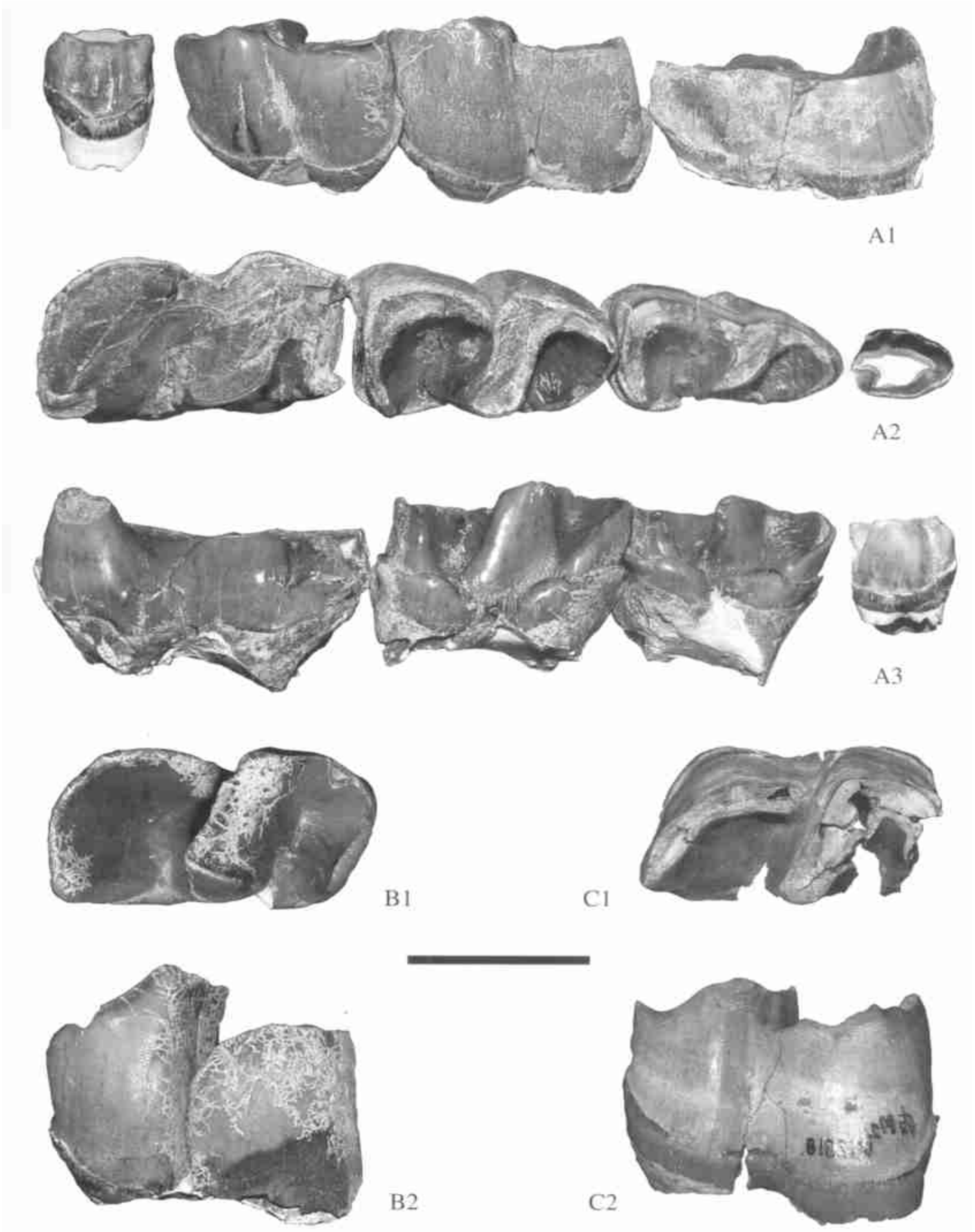

图 3　霍尔果斯准噶尔巨犀下颊齿

Fig. 3　Lower cheek teeth of *Dzungariotherium orgosense*

A. **左** left p2 (V 13815) **和左** left p3～m1 (V 13817 - 1～3), A1. **颊侧观** buccal view; A2. **冠面观** occlusal view; A3. **舌侧观** lingual view; B. **左** left m3 (V 13817 - 4), B1. **冠面观** occlusal view; B2. **颊侧观** buccal view; C. **右** right m2 (V 13818, **翻转** re-verse), C1. **冠面观** occlusal view; C2. **颊侧观** buccal view;

标尺 scale = 5 cm

齿特征有了较清楚的了解。

和上述临夏标本在大小和形态上比较接近的有 *Indricotherium*、*Paraceratherium* 和 *Dzungariotherium* 三个属的几个种。

1959 年 Gromova 根据她所掌握的产自咸海北岸及以北地区的大量材料,对此前所发现的巨犀化石作了全面的研究,将众多的属种合并为 2 属 3 种:*Indricotherium transouralicum* (= *I. asiaticum*, *I. minus*, *Baluchitherium grangeri*), *Paratheratherium prohorovi* (= *Aralotherium prohorovi*)和 *P. bugtiense*(= *Baluchitherium osborni*),并对 *Indricotherium* 和 *Paraceratherium* 这两个属在头骨、下颌、牙齿和几乎每一块肢骨上的区别作了非常细致的对比研究,奠定了我们今日对于上述 2 属 3 种的认识。

根据 Gromova (1959) 所提供的 *Indricotherium* 和 *Paraceratherium* 在牙齿上的区别特征判断,临夏的材料既不同于 *Indricotherium*,也不同于 *Paraceratherium*。和 *Paraceratherium* 相同而和 *Indricotherium* 不同(列在括号内)的特征有以下 6 点:1) 齿列中没有 P1(有);2) P2 为三角形(宽明显大于长的梯形);3) 上臼齿原尖内壁平(圆隆),常有垂向沟(无),反前刺发育更好(弱);4) M3 外后脊圆隆(在外脊后端处有角形突起);5) 下门齿(i1) 齿冠近中面前下角有台阶状突起(突起弱);6) p3 和 p4 为前窄后宽的梯形(近长方形),下内尖与下次脊完全愈合(下内尖呈孤立锥状)。和 *Indricotherium* 相同而和 *Paraceratherium* 不同(列在括号内)的特征有:1) P3 和 P4 的次尖比后小尖更向后伸展(不特别向后伸展);2) p3 下原尖外后角有角形突起(外后角圆隆),外中谷窄而深(宽浅)。另一方面临夏的材料也有一些和上述 2 个属都不同的特点:1) 除 i1 和 p2 外,所有牙齿的尺寸都较大(见表 1);2) 颊齿齿冠更高。这一点特别清楚地表现在牙沟材料中一个尚未磨耗的 m3 上(V 13817 - 4,图 3B)。其下次脊最高处的高(带齿带)为 62 mm。同一高度在 *Indricotherium* 和 *Paraceratherium* 中最高不超过 56 mm。

Dzungariotherium 属是邱占祥于 1973 年创建的。属型种 *D. orgosense* 的正型标本是同一老年个体的头骨和下颌。其头骨和下颌上的特征介于 *Indricotherium* 和 *Paraceratherium* 之间(详见邱占祥,1973)。遗憾的是,其牙齿深度磨耗,破坏较重,只有 M2 和 M3 的冠面形态保留尚好;所有牙齿长度的测量明显偏短(老年犀类皆如此),只有宽度测量比较准确。和 *D. orgosense* 正型相比,临夏标本在牙齿的大小,特别是在长度上,与它很接近,大于 *Indricotherium* 和 *Paraceratherium* 两属的材料(见表 1)。*D. orgosense* 正型标本齿列中没有 P1,P2 为前尖的三角形,M2 和 M3 原尖的内壁平,有垂向沟和前收缩沟,反前刺大,原尖内壁有齿带,M3 的外后脊圆隆而无角形突起等,这些特征都和临夏的标本一致。*D. orgosense* 正型标本和临夏的标本不同的是,前者的牙齿普遍更宽(见表 1)。考虑到巨犀种内个体大小变化较大这一公认的事实(Gromova, 1959, p. 12),把临夏的标本归入到 *D. orgosense* 种中目前是比较稳妥的。

Dzungariotherium 的另一个种,*D. turfanense*,是徐余瑄、王景文于 1978 年创建的。在大小和牙齿形态特征上,它和 *D. orgosense* 正型标本及临夏的材料很接近。我们赞同 Lucas和 Sobus (1989) 关于把它归入到 *D. orgosense* 的意见。

Lucas 和 Sobus (1989) 曾提出建议,把 *Indricotherium* 和 *Dzungariotherium* 都归入 *Paraceratherium*一个属。他们认为归入 *Indricotherium* 属的头骨特征,如粗壮的前颌骨,大的 I1,强壮而弯曲的颧弓,乳突 - 副枕突特别宽大,外耳道窄等都是雄性特征;而归入 *Para-*

表 1 某些亚洲巨犀牙齿大小的比较*

Table 1 Comparison of cheek teeth of some Asian indricotheres

(mm)

	Dzungariotherium				*Indricotherium*		*Paraceratherium*			
	orgosense			*turfanense*	*grangeri*	*transouralicum*	*prohorovi*	*bugtiense*	*tienshanense*	*sui*
	Linxia Basin		Junggar Basin	Turpan Basin	Mongolia	Kazak.-Mongolia	Aral	Pakistan	Hami Basin	Junggar Basin
	Yagou	Jiaozigou	Holotype		Holotype				Holotype	Holotype
		Qiu et al., 1990	Chiu, 1973	Xu et Wang, 1978	AM 18650#	Gromova, 1959	Gromova, 1959	F.-Cooper, 1911, 1924	Chow et Xu, 1959	Ye et al., 2003
P2 L	64.3		60.1^	53.5	42.6	41~47	48~51	48		
W	61.7		65^	53.3	58.7	50~58	44.5~52	43~45		
P3 L	66.2		54.4^	63.1~71.5	58.7	45~58	50~60	53~70		
W	76.2			81	82.9	69~78	68~77	58~64		
P4 L	89.8		62^	62.7~70	63.5	50~71	60~69	57~62		
W	98.8		109^	96.4~101	90	73~88	77~100	60~75		
M1 L							73~89	68~80		
W							84~103	63~82		
M2 L	132~133.5		99~104	96~109.5	89	85~96	96~108	74~96		
W	127~127.5		117~120	119~120.4	102.5	87~102	92~111	75~98		
M3 L**	92.7~101.7		99		75	67~86	78.5~90	78~97	123	
AW	113.5~119.4		120		101	84~100	97~107	70~92		
P2 L	31					35~38	29.5~33	29		39
W	23.3					25.5~28	21~24.5	18		31
p3 L	68.2	55.6		57		47~54	43~46	48		57
W	39.4	44.7		38		37~38.5	37~39	37		48
p4 L	74.1	65.2~71.3	74	62		50~58	55~63	57	76.3	65
W	46.4	47.1~56.6	57	57.5		40.5~45.5	44~50	45	49	53
m1 L	86	88	87	73		60~69	66~76	58	104	81
W	54.2		71	64		45.5~52.5	48~56	45	54.7	55
m2 L	91.2		99	90		72~85	71~83	70	130	91.6
W	62.4		67	64		46.5~61	50~60	45	56	58
m3 L**	94.3	100.5	101	89		80~92	80~96	79		102
W	52.2		65	58		50~60	50~60	49		59

* 牙齿长、宽或前宽均为可测量的最大值:上牙宽和下牙长和宽均在齿冠基部测量 Length [L] and width [W] or anterior width [AW] are maximum; W and AW of uppers and L & W of lowers are taken at crown base;

** 长仅为内侧长 Taken at inner side;

根据模型测量 Measured on cast;

^ 根据左侧重新测量 Re-measured on left side.

*ceratherium*及 *Dzungariotherium* 属的头骨的特征,如前颌骨及 I1 高度退缩,颧弓细弱,乳突 - 副枕突窄,外耳道宽等都是雌性特征。最近叶捷等(2003)根据下颌骨和下门齿的特征,已经明确地提出了不同的意见,认为 *Indricotherium*、*Paraceratherium* 和 *Dzungariotherium* 为 3 个独立的属,应予保留。我们同意叶捷等的意见。实际上,Gromova(1959)在其专著中已经非常详尽地讨论了 *Paraceratherium* 和 *Indricotherium* 之间的区别。这些区别不仅表现在头骨、下颌和牙齿中,而且在几乎每一块肢骨中都有表现。如果我们同意 Gromova (1959)的意见,认为 *Paraceratherium* 和 *Indricotherium* 是独立的属,那么我们也得承认 *Dzungario-therium*属的独立性。邱占祥(1973)在建属时就曾指出,该属既有 *Paraceratherium* 的,也有某些 *Indricotherium* 的特征,同时也有其自身的特征,例如退缩上翘的下颌联合部等。整体看来,*Dzungariotherium* 保留了若干 *Indricotherium* 属的特征,但更为进步,可能是从 *Indricotherium*这个属演化而来的。*Paraceratherium* 比 *Dzungariotherium* 小,但在许多特征上也很进步,甚至更为进步,可能代表了另一个进化的支系。

牙沟副巨犀 (新种) Paraceratherium yagouense **sp. nov.**

(图 4～5; 表 2)

正型标本 IVPP V 13820,一幼年头骨,带左、右 DP1～DP4、M1、尚未出齿的 M2 和右 P2,外耳道以后的部分缺失。

其他材料 V 13821-1～2,属于同一个体的左、右 M3。

特征 一种小个体的 *Paraceratherium*,和 *P. bugtiense* 差不多大小。吻部退缩,其长不超过 DP1～DP4 之长。无上门齿或犬齿;有 DP1,但无 P1。上颊齿冠高,外壁有薄层白垩质覆盖,M1 冠高接近齿冠最大长,原尖内壁基部变平,有垂向沟;上前臼齿(DP1 除外)和臼齿的反前刺大,基部堵塞中谷,和原尖以窄沟相隔,原尖具前收缩沟;次尖前收缩沟深;前、后齿带高脊状;无内齿带;上颊齿在前齿带中部、反前刺后端、后凹和内中谷入口处常有柱状突起。

名称来源 Yagou,牙沟,化石产出地点。

描述 吻部颊齿之前的部分左侧保存较好,但最前端已缺失(估计断失部分很小),保留长为 85 mm。自侧面看,吻部后端相当高,最上部为前颌骨鼻突的后端。此处总高 85 mm,其中前颌骨鼻突高仅 10 mm。齿槽缘向前平伸。吻部外壁微凹,内壁微凸,厚约 17～18 mm。齿槽缘没有犬齿或乳犬齿的痕迹或齿槽。在断面上看不到门齿或乳门齿的齿根。这表明,门齿已退失或很小。前颌骨鼻突的后端在 DP2 后端之上,离鼻切迹后端水平距离约 65 mm。眶下孔大,其后缘位于 DP3 后半部之上,离鼻切迹下缘约 20 mm。鼻切迹高大,后缘上半部接近垂直,下半部斜向前下方,鼻切迹最后点位于 DP4 后部之上。鼻骨仅保留后半部,两侧下垂,鼻 - 额骨缝距离鼻切迹后缘约 25 mm;鼻骨在鼻切迹后缘处的宽 70 mm;两鼻骨间保留中矢缝,鼻骨顶面微隆,腹面凹,侧缘薄,向中矢面方向逐渐变厚。眼眶前缘位于 M1 中部之上,鼻切迹和眼眶之间的距离 95 mm (沿骨面测量)。此处骨面微凹,由上颌骨和泪骨组成。上颌骨在面部的形状非常特殊(图 4 C,5 B),组成一个长的叶状面,向上几乎伸达顶面,其前缘组成鼻切迹的后缘。泪骨(图 4 C,5 B)也很宽大,和上颌骨一样,向上几乎伸达顶面,但稍低于上颌骨的上端;泪骨在眼眶前缘上至少有两个泪结节。眶上突很粗大。颧弓前端由颧骨组成,垂向高而侧向薄,颧弓向后高度降

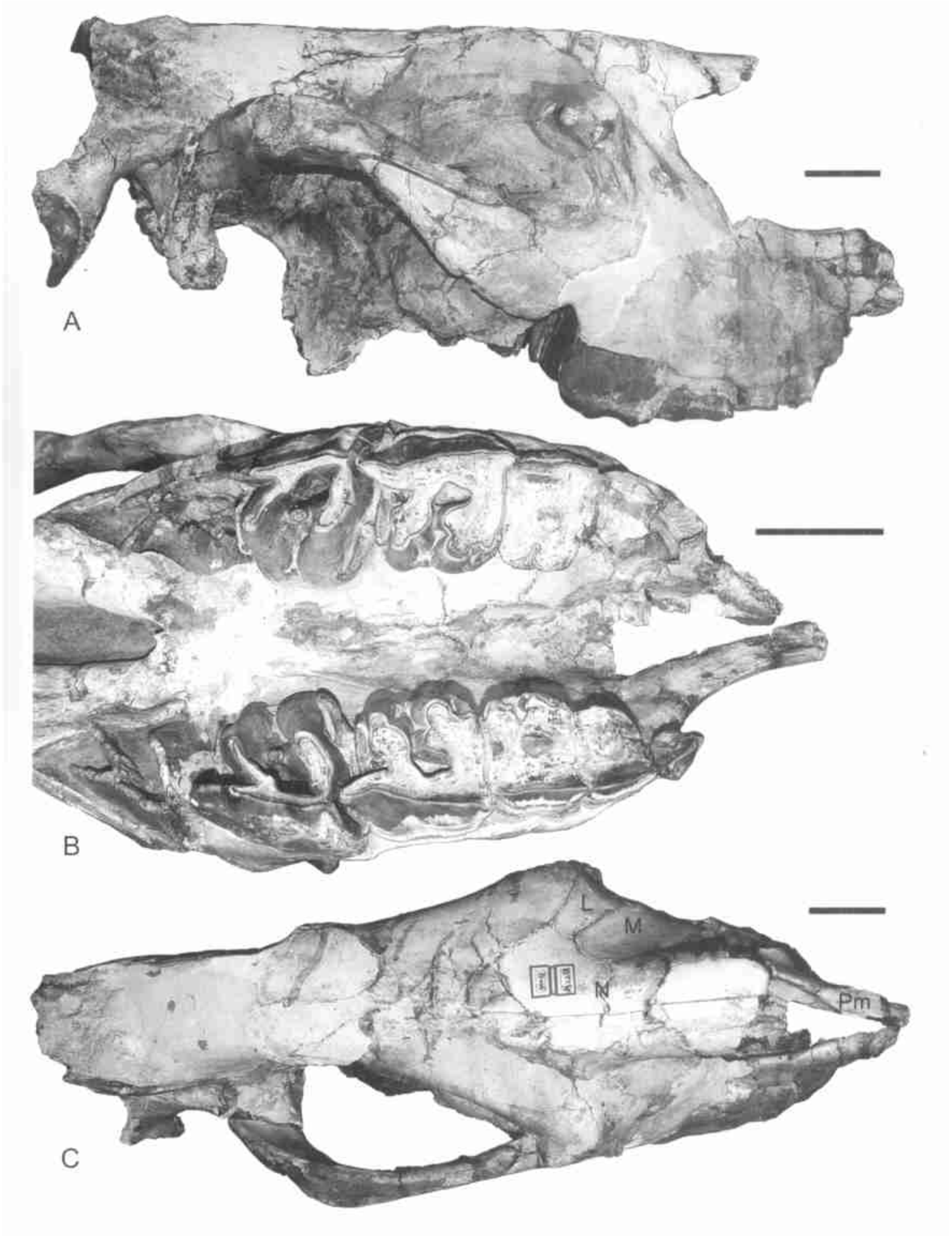

图 4　牙沟副巨犀(新种)头骨 (V 13820 ,**正型标本**)

Fig. 4　Skull (V 13820 , holotype) of *Paraceratherium yagouense* sp. nov.

A. **右侧观** right lateral view ;B. **上颊齿冠面观** crown view of upper cheek teeth ;C. **背面观** dorsal view

缩写 abbreviations : L. **泪骨** lacrimal ; M. **上颌骨** maxilla ; N. **鼻骨** nasal ; Pm. **前颌骨** premaxilla ;

标尺 scale = 5 cm

低,至关节凹之前高度最低。关节后突侧向扁,长约 65 mm,中部断面前后长 38.5 mm,横宽 20 mm。乳突与关节后突之间的距离宽,约 40 mm,宽于关节后突本身之前后长。腭部因受挤压变扁,硬腭后缘位于 M2 的前部。翼骨板很高大。卵圆孔位于关节后突内面的中部。翼蝶管很长(36 mm),后开口位于翼骨板的基部,距离卵圆孔 70 mm。自 DP1 前端至关节后突后缘长 470 mm。

所有牙齿的外壁都有很薄的白垩质覆盖。DP1 很小,三角形,后宽接近于外长,是乳齿中磨耗最轻的一个。外壁上有浅的前附尖褶。原脊呈双尖状,很短小,没有原尖。后脊斜向内后方,与外脊相连处细窄。内齿带在次尖之前很发育,脊形;外齿带细弱,但清楚。DP2 已深度磨耗;外壁近平直,冠面上只保留一个很小的封闭的中谷,中谷的前外缘为细褶状;牙齿前内角圆。外齿带与 DP1 者同。DP3 也深度磨耗,形成封闭的中谷,但中谷谷口仍然保存。反前刺很大,原尖的收缩沟难辨认,但次尖有前收缩沟。内齿带在原尖之前和谷口处呈瘤状。DP4 冠面形态保留完好。外壁上有微弱的前附尖褶。原脊粗壮,原尖内面圆隆,有深的前、后收缩沟。后脊中部膨大;次尖具深的前收缩沟。反前刺大,不至基部即将中谷封闭。后凹内有附属小柱。前、后齿带均很发育,脊形;内齿带在原尖、次尖内面消失;外齿带较 DP3 者更粗大些。右 P2 尚在齿槽中。可见齿冠很高,外脊高耸,顶部内弯,脊顶呈串珠状。原脊明显后弯与次尖连;外端与外脊连接处较低;原脊的顶端有 3 个明显的尖:原小尖最小,次尖最大,原尖居中;在原脊舌侧原尖和次尖间有垂直的浅沟。内齿带很发育,脊状。

M1 刚开始磨耗。外壁高,接近牙齿外壁的最大长。外壁较平,前附尖、前附尖褶和前尖肋都有,但微弱;后尖在外壁的顶部亦有细肋。原脊较直;原尖有明显的后收缩沟,原尖内壁圆隆,至基部逐渐变平并出现垂直沟。后脊斜向后伸,弱弧形,凸面向后;后脊的前面在接近外脊处有多个小褶。次尖仅至基部变粗,不与原尖愈合;前收缩沟明显,无后收缩沟。反前刺很大,至基部与后脊收缩沟之外的隆起愈合而将中谷封闭。在反前刺的后端另有一附属小柱,在牙齿中度磨耗时中谷即已封闭。后凹内也有一个小齿柱。齿带在前、后和外缘均发育,在前、后缘特别高耸,形成陡立的高脊形,在它们和原脊、后脊之间形成很深的沟;有的地方形成小柱;内缘没有齿带,仅在谷口处有一小突起。M2 仅外脊、原脊和后脊的顶端出露,脊顶呈串珠状。

V 13821 - 1(图 5 A)和 V 13821 - 2 为左、右 M3。这两个牙齿比上面归入 *D. orgosense* 的牙齿小很多,在形态上也有一些差别。它们的外壁上有薄层的白垩质覆盖;外后脊内半部接近垂直于牙齿长轴,所以与外半部之间形成的角较为明显;反前刺不大,但在中谷谷口处,在齿带之外还有一个低矮的小齿柱。内端长 68.5 mm,前宽 88.5 mm。

比较与讨论 上述幼年头骨的巨犀属性很清楚。首先,它的尺寸大。虽然在巨犀中是比较小的(与 *P. bugtiense* 和 *Benaratherium callstrati* 差不多大小),但比其他犀类仍然大出很多。就 V 13820 幼年头骨所能反映的特点判断,这件标本和 *Paraceratherium* 属最为接近。它们之间共同的特征是:1) 乳突和关节后突之间的间隙宽;2) 吻部退缩,上颌骨前端和前颌骨强烈退化;3) 鼻骨横断面(除最前端外)扁宽,下面凹,中缝处不特别变厚;4) DP1 后小尖和次尖相连,形成后脊(*Indricotherium* 中次尖孤立);5) 颊齿齿冠较高;6) M1(可能还有其他上臼齿)原尖内壁基部平,有垂向沟。牙沟的标本虽然在大小上和 *Benaratherium* 比较接近,但它们不会是同一种巨犀。根据 Gabunia (1964) 的描述,*Benaratherium* 的上臼

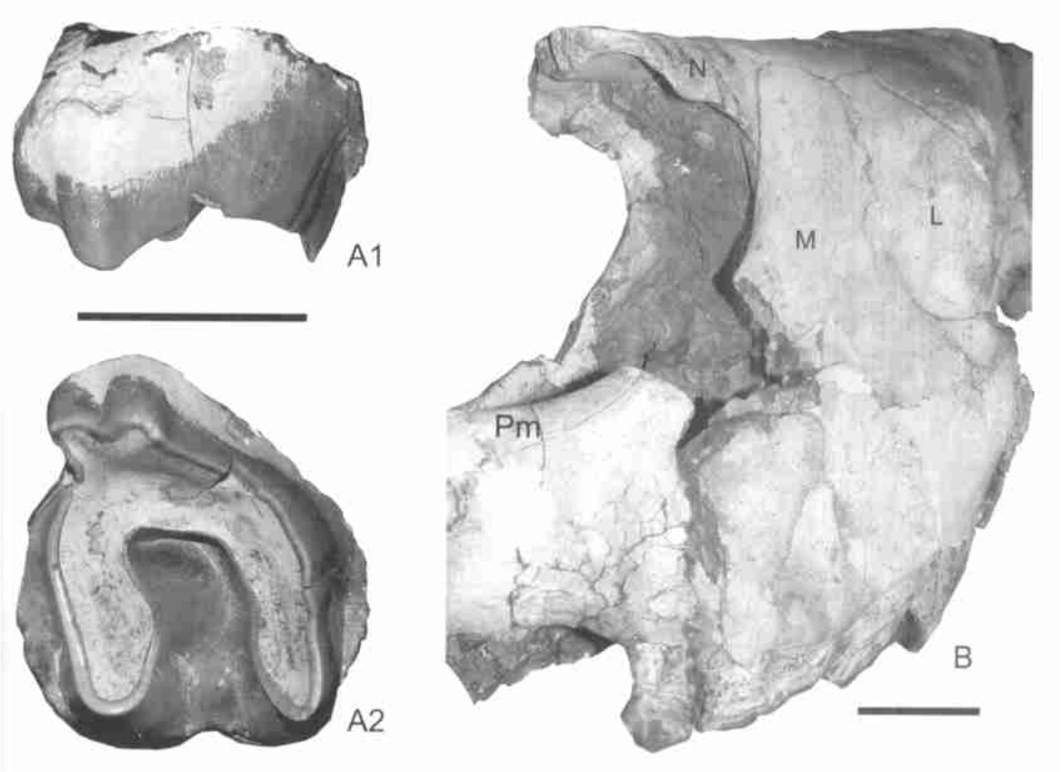

图 5　牙沟副巨犀(新种)

Fig. 5　*Paraceratherium yagouense* sp. nov.

A. **左** Left M3 (V 13821 - 1) ,A1. **颊侧观** buccal view;A2. **冠面观** occlusal view;B. **部分头骨前部** anterior part of skull (V 13820 , **正型标本** holotype) , **左前侧观** left antero-lateral view
标尺 scale = 5 cm , **缩写同图** 4 abbreviations as in Fig. 4

齿齿冠低,原尖没有收缩沟,反前刺不发育,更没有附属小柱,因此,是一类相当原始的巨犀。而牙沟的标本虽然个体小,但在构造上却是一种相当特化的 *Paraceratherium*。牙沟的标本也不会是 *Dzungariotherium*。后者在目前已知的 2 个种中头骨和牙齿的尺寸都很大,而且其关节后突和乳突之间的间隙都很窄。

和已知的 *Paraceratherium* 的 5 个种相比,牙沟的头骨和它们都有区别。在大小上,牙沟的标本比 *P. prohorovi* 的最小的标本还要小(见表 2)。此外,牙沟标本中 M1 次尖有非常大的反前刺,次尖有深的前收缩沟,以及前、后齿带特别发育,而内齿带除在中谷出口处有突起外,几乎完全缺失等,这些都和 *P. prohorovi* 不同。*Paraceratherium lipidus* 的材料中只有一件 M2 以后的头骨后部(徐余瑄、王景文,1978)。在大小上它和 *P. prohorovi* 差不多,M3 的内齿带也很发育。这件标本如果不是 *P. prohorovi*,也不会和牙沟的标本相混淆。*Paraceratherium tienshanense* 的材料很少(周明镇、徐余瑄,1959;邱占祥,1962)。这是 *Paraceratherium* 属中个体最大的一个种。最近创建的一个新种 *Paraceratherium sui* (叶捷等,2003)只有一个残破的下颌,无法和牙沟的头骨直接比较。但从该种的相当大的尺寸判断,把牙沟的头骨归入该种的可能性很小。

表 2 某些巨犀牙齿的比较

Table 2 Comparison of cheek teeth of some indricotheres (mm)

	Paraceratherium			*Indricotherium*
	yagouense sp. nov.	*bugtiense* *	*prohorovi*	*transouralicum*
	V 13820 (Holotype)	F.-Cooper, 1934	Gromova, 1959	
DP1 L	23.9	21	32.5	34
W	18.4	20	28	28
DP2 L	28.3	39	42～47	
W	36.6	38	42～51	
DP3 L	37	48	53～54	
W	47.7	43	54～58.5	
DP4 L	60	62	73	
W	58	53	70	
M1 L	74.3	75	73～89	
W	71	72	84～103	
H	～70		76	

* 根据图版测量和计算所得 Measured and calculated from plate.

和牙沟头骨在大小上比较接近的只有 *Paraceratherium bugtiense*。两者的尺寸都很小，是 *Paraceratherium* 属中个体小的类型。*Paraceratherium bugtiense* 的材料中有一件和牙沟的 V 13820 头骨接近同龄的头骨(Forster-Cooper, 1934, Fig. 20, Pl. 64: fig. 22)。和牙沟的头骨相比，它有以下几点不同之处：1) 其头骨面部很低，鼻切迹也很浅。前者在 P3～P4 处自齿槽缘至鼻骨顶面间之高，经测量推算为 140 mm，鼻切迹高约为 43 mm；同一高度在 V 13820中则为 200 mm 和 80 mm。2) 鼻切迹浅，其后缘仅达 DP2 中部；在 V 13820 中鼻切迹后缘位于 DP4 后端。3) 由于此处头骨较低，上颌骨的上半部和泪骨都变得长而低，这和V 13820中十分窄高的上颌骨及泪骨(见图 4C, 5B) 很不同。4) DP2～DP4 的反前刺很小，至磨耗很深时也不将中谷堵塞，原尖的前、后收缩沟很浅，内齿带发育，可能仅在次尖内壁处微弱或无；在 V 13820 中，从 DP3 和 DP4 看，反前刺很大，稍经磨耗即将中谷堵塞，原尖的前、后收缩沟很深，内齿带不发育。这都表明，牙沟的头骨和 *P. bugtiense* 在形态上差别很明显。它们不会是同一种。

牙沟标本虽然系一幼年个体，但显示出了某些过去在 *Paraceratherium* 属中没有发现过的特征。例如，其上颊齿的外壁上都有薄层的白垩质覆盖，在 M1 及部分乳上前臼齿上有发育的柱状突起。此外，它的上颌骨和泪骨的形状也很特殊(见上)。在 *Paraceratherium* 属其他各种的材料中还没有类似的记载。不排除牙沟的标本乃是一新属的可能性。

牙沟的两个单独的 M3 归入本种主要是由于它们小的尺寸，外壁具白垩质层和中谷有附属小柱。但它们的原尖和次尖没有收缩沟，反前刺不大，齿带也不特别高耸，这些性状和上述头骨上 M1 的有些不同。所以上述归属是否正确还有待于更多材料的证实。

3 结论

1) 临夏盆地至今发现两种巨犀。一种个体大，是 *Dzungariotherium orgosense*；另一种很小，为 *Paraceratherium* 属的一个新种：*P. yagouense*。这两个种在大小和形态上都很容易

区别。

2) 巨犀的演化历史看来比过去想象的更多样化。*Indricotherium*、*Paraceratherium* 和 *Dzungariotherium* 是 3 个独立的属,不能归为一属。*Paraceratherium* 可能代表一个支系, *Indricotherium*和 *Dzungariotherium* 可能代表另一个支系。Gabunia (1964) 记述的高加索的 *Benaratherium* ,虽然材料很少,则是又一类巨犀的代表。

3) *Dzungariotherium orgosense* 的正型发现于新疆准噶尔盆地的玛纳斯群的褐色层中,其时代为晚渐新世。临夏盆地所发现的两种巨犀化石表明,含巨犀层位的地质时代应为晚渐新世,而不是早先所推测的早中新世。

INDRICOTHERES (PERISSODACTYLA, MAMMALIA) FROM OLIGOCENE IN LINXIA BASIN, GANSU, CHINA

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Key words Linxia Basin of Gansu Province, Oligocene, Indricotheriidae

Summary

The indricothere fossils from the Linxia Basin, Gansu Province, were first reported by Qiu et al. in 1990. The fossils were purchased from the Dongxiang county drugstore, allegedly from the deposits near the bottom of the Jiaozigou ravine. The age of the fauna was then considered as early Miocene because of the presence of a segment of proboscidean tusk among the purchased fossils.

In 2002, while checking the fossils kept by a local dragon-bone dealer in the Hezheng County, the authors of the present paper found some well preserved Oligocene fossils, such as teeth of *Tsagan-omys*, *Aprotodon*, some chalicothere, skull and teeth of indricotheres etc, allegedly from a ravine called Yagou of the Dongxiang County. Subsequent geologic work not only confirmed the provenance of the Yagou fossils, but also found that fossils from both Yagou and Jiaozigou ravines are from the same fossiliferous level, i.e., from the lower part of the Jiaozigou Formation. We failed to find any traces of proboscidean fossils in both localities. It is highly possible that the proboscidean tusk from the Jiaozigou ravine came from some overlying deposits, then mixed with the Oligocene fossils. Without the proboscidean fossils the lower part of the Jiaozigou Formation can well be assigned to late Oligocene, rather than early Miocene as previously suggested. The indricothere fossils are the best part of the Yagou fossils so far collected and may be of greater significance in age determination.

Dzungariotherium orgosense **Qiu (= Chiu), 1973**

(Figs. 1～3; Table 1)

Material IVPP V 13571, right P2; V 13807, right P3; V 13862, right P4; V 13808-1～3, left P4, left and right M2; V 13809～13813, 5 M3; V 13814, left i1; V 13815～13816, 2 left p2; V 13817-1～4, left p3～m1 and m3; V 13818, right m2; and V 13819, distal part of Mc (or Mt) III.

Brief description The P2 is triangular, longer than wide. Labial wall strongly convex, with long parastyle. Protoloph S-form, extending postero-lingually. Metaloph slightly longer than protoloph, attenuated labially; hypocone strongly enlarged. Small crochet and crista are present. Medisinus is wide, blocked lingually at crown base. Postfossette is large. The tooth is surrounded by con-

tinuous cingulum. The P3 is trapezoid in form. Protoloph is curved back, joining with large hypocone, with a groove on lingual wall between protocone and hypocone. Metaconule forms a ridge, linking ectoloph and hypocone, closing the medisinus. Postfossette is small, open posteriorly. Crista is present, but small and rounded. Cingulum is as in P2. The P4 is similar to P3, but larger, with deeper parastyle fold, lingual groove of protoloph anterior to hypocone, and metaconule more curved.

The M2 is trapezoid in form, longer externally and wider anteriorly. Parastyle is very prominent and parastyle fold is deep. Protocone has narrow anterior, but wide posterior constriction folds, and a narrow fold on flattened lingual surface. Antecrochet is large. Metaloph shorter than protoloph, with narrow anterior hypocone constriction fold. Anterior and posterior cingula are high-ridged, but the lingual and labial cingula are weak. The M3 is triangular, with the vestigial, highly reduced posterior end of ectoloph. Cingulum is as in M2.

The i1 is close to that of *Paraceratherium prohorovi* described by Gromova (1959), but with the cross-section of the crown more laterally compressed and the upper ridge undeveloped.

The crowns of all the lower premolars are surrounded by continuous cingula. The p2 is very small, single-rooted. Its crown is triangular in form. The main cusp is large, sending 3 ridges: anterior, postero-lingual and posterior ones. The P3 is also triangular in form. The metalophid is almost complete, with long ridge-formed paraconid and angled postero-labial corner, covered with tubercles. The transverse ridge of the hypolophid is very long. Entoconid is completely merged with hypolophid, with its lingual end anteriorly curved. The p4 is transitional between p4 and m1 in structure, trapezoid in form. Metalophid is U-shaped, with long transverse lophids, but rounded postero-labial corner. Entoconid is enlarged and curved anteriorly. The lower molars differ from the premolars in having higher paralophids and entoconids, more rounded postero-labial corners of metalophids, shallower labial valleys and weaker cingulum.

Comparison and discussion Morphologically, the above described p3 and p4 from Yagou are almost identical to those from Jiaozigou described by Qiu et al. (1990), possessing mixed features of both *Indricotherium* and *Paraceratherium*. These features include the tapering of the premolars anteriorly, the well developed and postero-lingually extended paralophid, the complete confluence of the entoconid with the hypolophid (more similar to *Paraceratherium*), but the angled postero-labial corner of the metalophid with accessory tubercles in p3 (more similar to *Indricotherium*). In size the p3 and p4 from Yagou are slightly larger than those from Jiaozigou, but both are larger than those of *Indricotherium* and *Paraceratherium* (Table 1). It is reasonable to assign them to one and the same species.

Based on the better preserved material from Yagou, the dental characters of this large Linxia indricothere form is better known. Morphologically it is intermediate between *Indricotherium* and *Paraceratherium*. It is similar to *Paraceratherium* in the following features: loss of P1; triangular form of P2; protocone lingually flattened, with vertical groove in upper molars; more reduced vestige of the posterior end of ectoloph in M3; the large tubercle on mesial side in the i1; the narrowed anterior parts in p2 and p3; and the confluence of the entoconid with hypolophid. On the other hand, the Yagou form is close to *Indricotherium* in having more posteriorly extended hypocone in P3～P4, the deeper parastyle folds in upper cheek teeth, the longer protoloph, the angled postero-labial corner of the metalophid and the deeper labial valley in p3 and p4. However, the teeth of the Yagou form are larger and may be of higher crowned as compared with those of above 2 genera (see Table 1).

Dzungariotherium orgosense was created by Qiu in 1973, based on skull with lower jaw of a very old individual with its teeth heavily worn. Morphologically speaking, the only comparable teeth between the Yagou and the type of *Dzungariotherium orgosense* are the M2 and M3. They resemble each other very closely in having flattened protocone lingual surface with vertical groove and cingulum, the anterior protocone constriction groove, and the large antecrochet etc. Their slight size dif-

ferences between them (see Table 1) seem to fall within the range of variation of a species, which has been recognized as particularly large in indricotheres (Gromova, 1959).

Lucas and Sobus (1989) suggested synonymizing *Indricotherium* and *Dzungariotherium* with *Paraceratherium*, which has priority over the former two, based on the notion that the morphologic differences between the three genera were in fact merely sexual ones. Recently Ye et al. (2003), based partly on lower jaw and incisors, clearly expressed their notion to maintain the 3 genera as separate and valid ones, with which we fully agree. In fact, in her monograph on indricotheres Gromova (1959) already demonstrated in great detail the distinctive characters on skull, lower jaw, teeth, and almost every limb bones between *Indricotherium* and *Paraceratherium*. If we agree with Gromova's opinion, it is inevitable to consider *Dzungariotherium* as a valid genus as well. *Dzungariotherium* can be characterized, on the one hand, by the mixed features of both *Indricotherium* and *Paraceratherium*, on the other hand, by the strongly reduced and upturned symphysis, rather unique characters among the indricotheres.

Paraceratherium yagouense **sp. nov.**

(Figs. 4～5; Table 2)

Holotype IVPP V 13820, a juvenile skull with left and right DP1～DP4, M1, and unerupted M2 and right P2.

Other material V 13821 - 1～2, left and right M3 of one and the same individual.

Diagnosis Small, close to *P. bugtiense* in size. Length of muzzle anterior to DP1 not surpassing DP1～DP4. No upper incisors, canines, and P1. Cheek teeth high crowned, with thin layers of cement. M1 possesses crown height equaling the maximum crown length, protocone with lingual groove; DP2～M1 with large antecrochet, anterior protocone and hypocone constriction grooves, high and ridge-formed anterior and posterior cingula, lacking lingual cingulum, often with pillar-formed tubercles in the middle of anterior cingulum, medisinus, postfossette and posterior to antecrochet.

Etymology Yagou is the locality where the fossils were collected.

Brief description The muzzle is strongly reduced in length. The premaxilla and the maxilla anterior to the DP1 form a thin plate, 85 mm high at the level of the posterior end of the nasal process of the premaxilla. Neither incisors and canines, nor their roots, can be detected on the alveolar border. The posterior wall of the nasal notch lies above the posterior part of the DP4. The large infraorbital foramen is above the posterior end of the DP3, and the anterior rim of the orbit is above the middle of the M1. The maxilla extends postero-superiorly, forming a long lobe (Figs. 4C and 5B: M). The facial part of the lacrimal is very high (Figs. 4C and 5B: L). The frontal surface of the nasals is convex with sagittal suture, and their ventral surface concave. The posterior part of the lateral borders of nasals hangs down. The supraorbital process is large. The postglenoid process is 65 mm long, laterally compressed. The distance between the postglenoid and mastoid processes is 40 mm.

A thin layer of cement can be seen on labial walls of all the upper cheek teeth. The DP1 is the least worn of the deciduous teeth. It is triangular, with very small protoloph, but long and complete metaloph. The inner cingulum is well developed anterior to the hypocone. The labial cingulum is fine. Both DP2 and DP3 are heavily worn, leaving closed medisinus in the center of the crown. In DP4 the anterior and posterior protocone constriction grooves and the anterior hypocone constriction groove are clearly shown. The antecrochet is large, blocking the medisinus when not heavily worn. An accessory pillar is present in the postfossette. The anterior and posterior cingula are well developed, ridge-like in form. The M1 is high crowned, with its crown height equaling the maximum length of the ectoloph. The straight protoloph is longer than the metaloph, which is curved with its posterior border convex. Its protocone, hypocone and cingulum are constructed as in DP4. There are also accessory pillar-formed tubercles. Two M3 of the same individual (V 13821-1～2) have been

referred to the present species, chiefly because of the presence of cement cover and their small size, comparable with the Yagou skull but evidently smaller than those of *D. orgosense*. However, the antecrochet is smaller and the accessory tubercles are less developed than in the above described M1.

Comparison and discussion Although small compared with majority of the other indricotheres, the above described skull is much larger than any other rhinocerotids. The following characters of the skull show its *Paraceratherium* affinity: the wide distance between the postglenoid and mastoid processes, the strongly reduced muzzle, the wide and thin nasal bones, the presence of metaloph in DP1, the high crowned cheek teeth, and the presence of vertical groove on the flattened inner surface in M1 (and possibly in other upper molars) etc.

Four of the five *Paraceratherium* species (*P. prohorovi*, *P. tienshanense*, *P. lipidus*, and *P. sui*) can easily separated from the Yagou form simply by size. They are all much larger. In addition, the complete loss of the upper incisors and canines, the particularly large antecrochet, the deep constriction grooves and the peculiar pillar-formed tubercles expressed in the upper cheek teeth of the Yagou form are rather unique among the indricotheres so far described.

Paraceratherium bugtiense is only species of the genus comparable with the Yagou form in size. However, comparison of similarly young aged skull parts of the two forms shows clearly that they are of different species. In *P. bugtiense* the part of the skull anterior to the orbit is very low, with shallow and low nasal notch, and low and wide maxilla and lacrimal bones (see Forster-Cooper, 1934, Fig. 20), the DP2～DP4 with small antecrochet and shallow constriction grooves (see Forster-Cooper, 1934, Pl. 64, Fig. 22). These are quite different from those in the Yagou form as described above. Thus a new species is created for it: *Paraceratherium yagouense*.

Concluding remarks

1) Two indricothere species coexisted in the Linxia Basin: the larger *Dzungariotherium orgosense* and the smaller *Paraceratherium yagouense*.

2) The evolutionary history of the indricotheres seems to be more complicated than previously conceived. *Indricotherium*, *Paraceratherium* and *Dzungariotherium* are three valid genera, and can not be lumped into one single genus *Paraceratherium* as Lucas and Sobus (1989) once suggested.

3) The age of the fossil-bearing deposits of the Linxia Basin is late Oligocene rather than early Miocene as previously suggested by Qiu et al. (1990).

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